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Evaluating Sustainability in the Protection of Intangible Cultural Heritage Through Sports Practices under the Triangular UnderConorm

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Abstract: The identity and customs of communities around the world depend heavily on the preservation of intangible cultural heritage (ICH). As a social and cultural activity, sports are increasingly being used as a means of preserving these intangible components. This study uses a multi-criteria decision-making (MCDM) framework to assess how sustainable sports practices are in preserving ICH. The study offers a formal foundation for evaluating and improving sports-related heritage efforts by defining important evaluation criteria and examining a collection of representative options. We use the MARCOS methodology as an MCDM methodology to rank the alternatives based on a set of criteria. This study uses four criteria and 15 alternatives. The Triangular UnderConorm is used to deal with the different decision matrix. The results are tested by sensitivity analysis. The results emphasize how important cultural authenticity, educational value, environmental alignment, and local involvement are to long-term preservation. Policymakers, cultural institutions, and community stakeholders are given recommendations.

Keywords: Triangular UnderConorm; Sustainability; Sports Practices; Protection of Intangible Cultural Heritage.

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1. Introduction

A fundamental component of cultural identity, intangible cultural heritage (ICH) includes customs, representations, expressions, knowledge, and abilities that have been passed down through the centuries. It is dynamic, living, and firmly anchored in local customs and values, in contrast to material legacy[1], [2].

Conventional and contemporary sports are among the less studied yet significant channels for spreading ICH. Around the world, a lot of sports are intricately woven with regional traditions,

festivals, and rituals. Indigenous running ceremonies, traditional wrestling, and martial arts with philosophical and ceremonial connotations are a few examples[3], [4].

Sports can be used as a cultural repository as well as a means of staying active, especially as modernity and globalization put pressure on indigenous knowledge and cultural manifestations. These methods can aid in reviving endangered customs if they are in line with sustainability ideals[5], [6].

In this context, sustainability refers to the ability of communities to sustain these sporting practices while upholding cultural integrity, intergenerational transmission, and environmental stewardship. Therefore, social and ecological factors must be considered while assessing sustainability[7], [8].

To evaluate the sustainability of sports-based ICH efforts, this study suggests an evaluative framework that considers several cultural, social, and environmental factors. The assessment seeks to identify the best practices and direct upcoming projects[9].

Cultural ministries, non-profits, sports organizations, and community organizations are among the stakeholders engaged in the safeguarding of ICH, and they need a standardized yet flexible approach to rank initiatives that yield long-term benefits[10], [11].

This work closes the gap between applied sport-based interventions and heritage conservation theory by incorporating decision-making tools into cultural evaluation. It makes comparative study possible in a variety of cultural and geographic contexts[12], [13].

The result is a strategy that guides the creation of new, long-lasting programs for preserving intangible cultural traditions through sports in addition to rating ongoing projects. It adds to the growing conversation about cultural sustainability in unconventional fields.

To quantitatively Evaluating Sustainability in the Protection of Intangible Cultural Heritage Through Sports Practices, MCDM issue has implemented several multi-criteria decisions making (MCDM) methodologies. Evaluating Sustainability in the Protection of Intangible Cultural Heritage Through Sports Practices in an MCDM framework is carried out by a team of knowledgeable specialists[14], [15].

Their disparate areas of expertise, however, might cause them to clash, which would result in ineffective assessment results. As a result, one of the primary challenges for Evaluating Sustainability in the Protection of Intangible Cultural Heritage Through Sports Practices is increasing expert consensus.

Numerous MCDM techniques, including MARCOS, and average method, can be used to produce the assessment score. These strategies fall into two categories: outranking-based MCDM techniques and utility values-based MCDM techniques. The latter type can demonstrate the intricate relationship between sports in greater detail than the former type[16], [17].

One of the most important tasks for Evaluating Sustainability in the Protection of Intangible Cultural Heritage Through Sports Practices framework based on the MCDM method is to aggregate the opinions of experts to produce the collective analysis results. They are effective at aggregating information. Most of them assume that specialists make their own decisions. Researchers, shown the interfering effects of experts in the decision-making process through a

series of behavioral experiments. Therefore, modeling such an effect is crucial to obtaining trustworthy analysis conclusions[18], [19].

To address the Evaluating Sustainability in the Protection of Intangible Cultural Heritage Through Sports Practices MCDM that integrates average method and MARCOS is presented. The following is an introduction to the suggested method's primary contributions:

The average method is used to compute the criteria weights between the criteria which affect the decision-making process.

The MARCOS method is used to rank the alternatives based on the different decision matrix between the criteria and alternatives.

The triangular UnderConorm is used to combine the decision matrix.

The sensitivity analysis is applied by changing the criteria weights by eight cases. The results show the ranks of alternatives are stable.

This study aims to Evaluating Sustainability in the Protection of Intangible Cultural Heritage Through Sports Practices by suing four criteria and 15 sports.

2. Triangular UnderConorm

We can define the triangular UnderConorm on the interval [20].

(1)

And for any (2)

, commutativity (3)

associativity (4)

monotonicity (5)

, or the neutral elements is (6)

(7)

The steps of the MARCOS method are shown below to rank the alternatives.

Create the decision matrix.

Four experts created the decision matrix using interval values. These matrices are combined using the . The decision matrix is used to obtain the weights of criteria by the average method to show the best and worst criterion effect on the ranks of alternatives.

Compute the normalized decision matrix for the positive and cost criteria.

Compute the weighted matrix.

Calculate the utility degree numbers.

Compute the utility function

Rank the options.

3. Results and Discussion

This section shows the results of the proposed approach to select the best criterion and alternative from different alternatives. Three experts created the decision matrix as shown in Table 1. We use the to combine the decision matrix. We use four criteria and 15 alternatives (sports) as: Cultural Integrity (C1) – The extent to which the sport practice retains its original meaning, symbolism, and community significance. Intergenerational Transmission (C2) – The ability of the practice to engage and educate youth, ensuring continuity. Environmental Compatibility (C3) – How well the practice aligns with principles of environmental sustainability (e.g., resource use, ecological footprint). Community Participation (C4) – The level of local engagement, ownership, and inclusiveness in sustaining the sport practice.

Table 1. The opinions of experts.

	C_1	C_2	C_3	C_4
A_1	[-1,0.99]	[-2,0.85]	[-3,0.75]	[-4,0.65]
A_2	[-1,0.99]	[-7,0.15]	[-6,0.35]	[-5,0.25]
A_3	[-2,0.85]	[-3,0.75]	[-4,0.65]	[-5,0.25]
A_4	[-4,0.65]	[-3,0.75]	[-2,0.85]	[-1,0.99]
A_5	[-5,0.25]	[-4,0.65]	[-3,0.75]	[-2,0.85]
A_6	[-5,0.25]	[-5,0.25]	[-4,0.65]	[-5,0.25]
A_7	[-6,0.35]	[-6,0.35]	[-3,0.75]	[-6,0.35]
A_8	[-5,0.25]	[-4,0.65]	[-6,0.35]	[-7,0.15]
A_9	[-6,0.35]	[-3,0.75]	[-2,0.85]	[-1,0.99]
A_{10}	[-7,0.15]	[-1,0.99]	[-2,0.85]	[-3,0.75]
A_{11}	[-3,0.75]	[-4,0.65]	[-5,0.25]	[-6,0.35]
A_{12}	[-1,0.99]	[-7,0.15]	[-6,0.35]	[-6,0.35]
A_{13}	[-7,0.15]	[-6,0.35]	[-5,0.25]	[-7,0.15]
A_{14}	[-4,0.65]	[-5,0.25]	[-6,0.35]	[-1,0.99]
A_{15}	[-7,0.15]	[-6,0.35]	[-5,0.25]	[-4,0.65]
	C_1	C_2	C_3	C_4
A_1	[-4,0.65]	[-2,0.85]	[-3,0.75]	[-4,0.65]
A_2	[-3,0.75]	[-7,0.15]	[-6,0.35]	[-4,0.65]
A_3	[-2,0.85]	[-3,0.75]	[-4,0.65]	[-3,0.75]
A_4	[-1,0.99]	[-3,0.75]	[-2,0.85]	[-2,0.85]
A_5	[-7,0.15]	[-4,0.65]	[-3,0.75]	[-1,0.99]
A_6	[-4,0.65]	[-4,0.65]	[-4,0.65]	[-7,0.15]
A_7	[-3,0.75]	[-3,0.75]	[-3,0.75]	[-6,0.35]
A_8	[-5,0.25]	[-4,0.65]	[-4,0.65]	[-3,0.75]
A_9	[-6,0.35]	[-3,0.75]	[-2,0.85]	[-1,0.99]
A_{10}	[-7,0.15]	[-4,0.65]	[-3,0.75]	[-2,0.85]
A_{11}	[-3,0.75]	[-4,0.65]	[-5,0.25]	[-6,0.35]
A_{12}	[-2,0.85]	[-1,0.99]	[-4,0.65]	[-1,0.99]

A_{13}	[-7,0.15]	[-4,0.65]	[-3,0.75]	[-2,0.85]
A_{14}	[-1,0.99]	[-7,0.15]	[-6,0.35]	[-3,0.75]
A_{15}	[-5,0.25]	[-6,0.35]	[-5,0.25]	[-4,0.65]
	C_1	C_2	C_3	C_4
A_1	[-1,0.99]	[-2,0.85]	[-3,0.75]	[-4,0.65]
A_2	[-7,0.15]	[-7,0.15]	[-6,0.35]	[-5,0.25]
A_3	[-6,0.35]	[-1,0.99]	[-4,0.65]	[-5,0.25]
A_4	[-5,0.25]	[-7,0.15]	[-1,0.99]	[-1,0.99]
A_5	[-4,0.65]	[-6,0.35]	[-7,0.15]	[-1,0.99]
A_6	[-3,0.75]	[-5,0.25]	[-6,0.35]	[-7,0.15]
A_7	[-2,0.85]	[-4,0.65]	[-5,0.25]	[-6,0.35]
A_8	[-5,0.25]	[-4,0.65]	[-6,0.35]	[-1,0.99]
A_9	[-6,0.35]	[-3,0.75]	[-2,0.85]	[-1,0.99]
A_{10}	[-7,0.15]	[-1,0.99]	[-7,0.15]	[-6,0.35]
A_{11}	[-3,0.75]	[-4,0.65]	[-5,0.25]	[-6,0.35]
A_{12}	[-7,0.15]	[-6,0.35]	[-5,0.25]	[-5,0.25]
A_{13}	[-1,0.99]	[-7,0.15]	[-6,0.35]	[-6,0.35]
A_{14}	[-5,0.25]	[-4,0.65]	[-3,0.75]	[-7,0.15]
A_{15}	[-7,0.15]	[-6,0.35]	[-5,0.25]	[-1,0.99]
	C_1	C_2	C_3	C_4
A_1	[-6,0.35]	[-7,0.15]	[-2,0.85]	[-7,0.15]
A_2	[-7,0.15]	[-1,0.99]	[-1,0.99]	[-1,0.99]
A_3	[-7,0.15]	[-2,0.85]	[-7,0.15]	[-2,0.85]
A_4	[-2,0.85]	[-2,0.85]	[-2,0.85]	[-5,0.25]
A_5	[-1,0.99]	[-1,0.99]	[-1,0.99]	[-1,0.99]
A_6	[-7,0.15]	[-7,0.15]	[-7,0.15]	[-2,0.85]
A_7	[-1,0.99]	[-3,0.75]	[-4,0.65]	[-5,0.25]
A_8	[-5,0.25]	[-4,0.65]	[-3,0.75]	[-3,0.75]
A_9	[-4,0.65]	[-3,0.75]	[-2,0.85]	[-2,0.85]
A_{10}	[-7,0.15]	[-1,0.99]	[-2,0.85]	[-5,0.25]
A_{11}	[-2,0.85]	[-7,0.15]	[-3,0.75]	[-5,0.25]
A_{12}	[-2,0.85]	[-1,0.99]	[-4,0.65]	[-1,0.99]
A_{13}	[-1,0.99]	[-7,0.15]	[-5,0.25]	[-2,0.85]
A_{14}	[-2,0.85]	[-1,0.99]	[-2,0.85]	[-3,0.75]
A_{15}	[-1,0.99]	[-2,0.85]	[-7,0.15]	[-4,0.65]

Then we compute the criteria weights by the average method. We show the descriptions for the criteria given weights in the context of evaluating sustainability in the protection of Intangible Cultural Heritage (ICH) through Sports Practices:

C1 (Weight: 0.2355), Cultural Integrity is a significant factor in preserving the authenticity and original values of a sport-related heritage practice. A weight of 0.2355 reflects its strong influence in the overall evaluation. Practices that preserve traditional rituals, symbols, and meanings score higher in this criterion.

C2 (Weight: 0.2566), This criterion assesses how effectively the sport practice is passed from older to younger generations. With a weight of 0.2566, it holds the highest importance, emphasizing the need for continuity and youth engagement to ensure long-term sustainability of the ICH.

C3 (Weight: 0.2455), Environmental Compatibility examines whether the sport is practiced in a way that respects ecological balance, uses local materials, and minimizes environmental harm. A weight of 0.2455 indicates its nearly equal importance to other social-cultural criteria in sustainable evaluations.

C4 (Weight: 0.2624), This criterion evaluates the level of local community involvement in organizing, preserving, and participating in the sport. With the highest weight of 0.2624, it reflects the central role of community ownership in sustaining ICH through active engagement and shared responsibility.

Eq. (8) is used to compute the normalized decision matrix for the positive and cost criteria as shown in Fig 1.

Eq. (10) is used to compute the weighted matrix as shown in Fig 2.

Eqs. (11-13) are used to calculate the utility degree numbers as shown in Fig 3.

Eqs. (14-16) are used Compute the utility function as shown in Fig 4 and Fig 5.

Rank the options as shown in Fig 6.

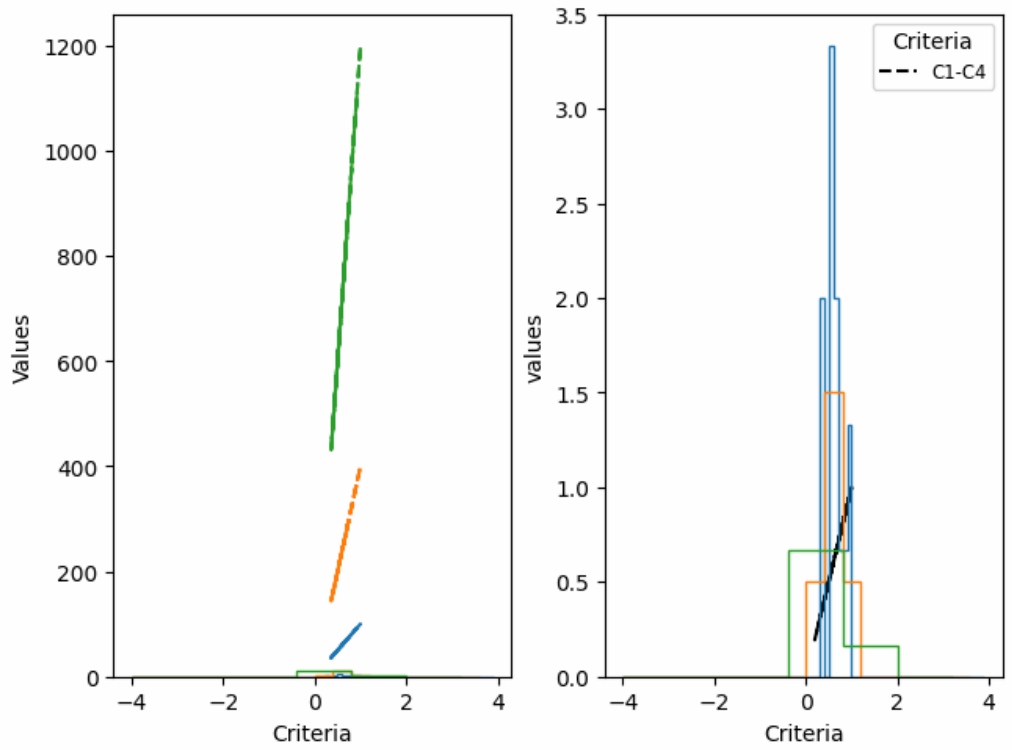

Fig 1. The normalized decision matrix.

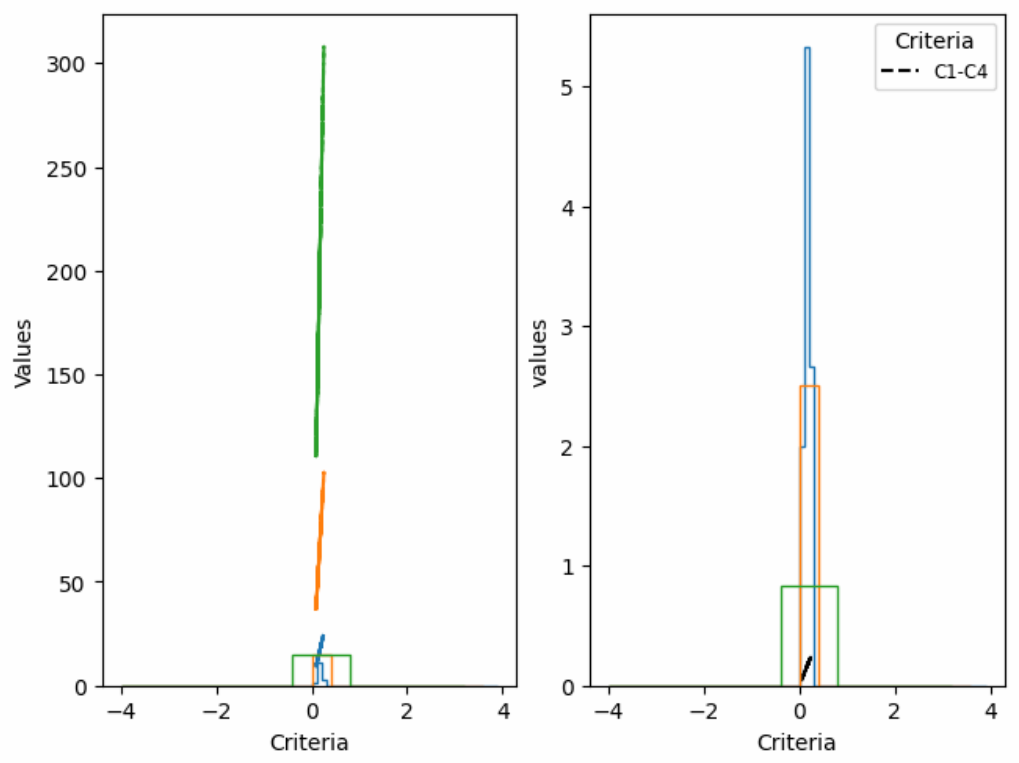

Fig 2. The weighted matrix.

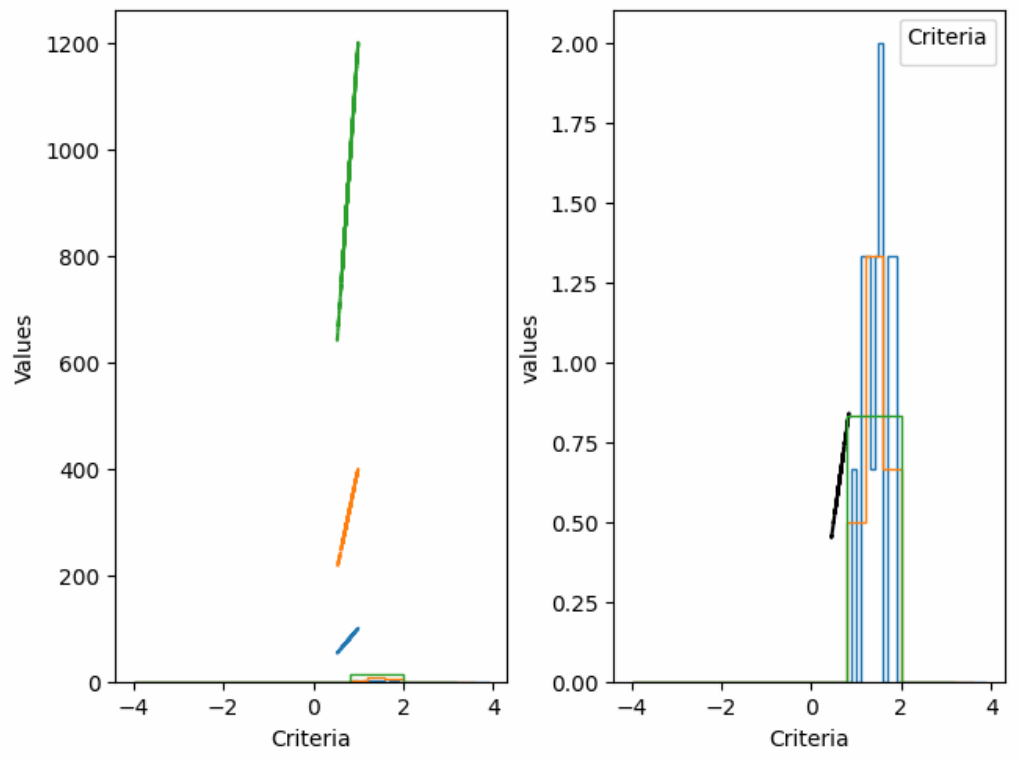

Fig 3. The values of .

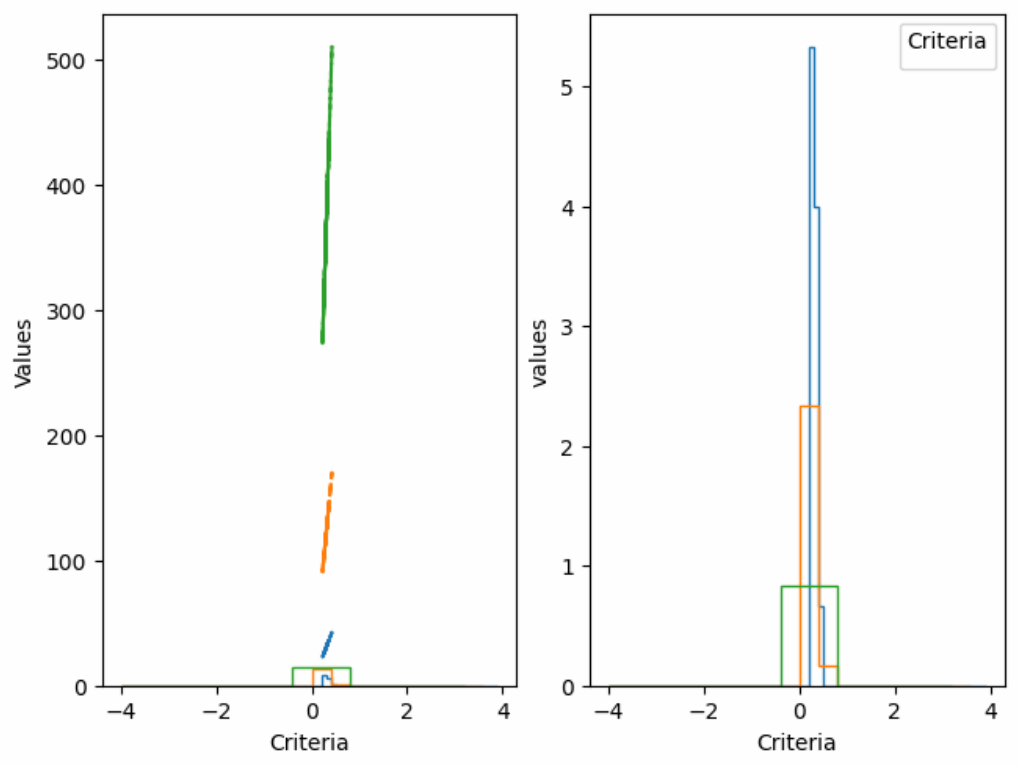

Fig 4. The values of .

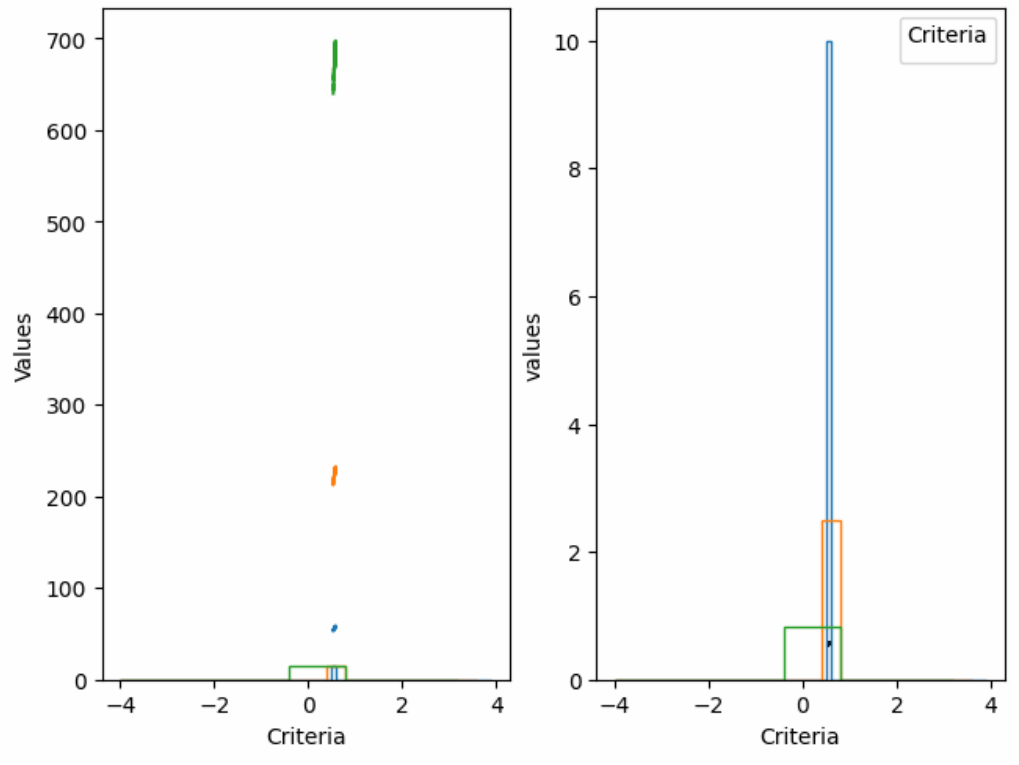

Fig 5. The values of .

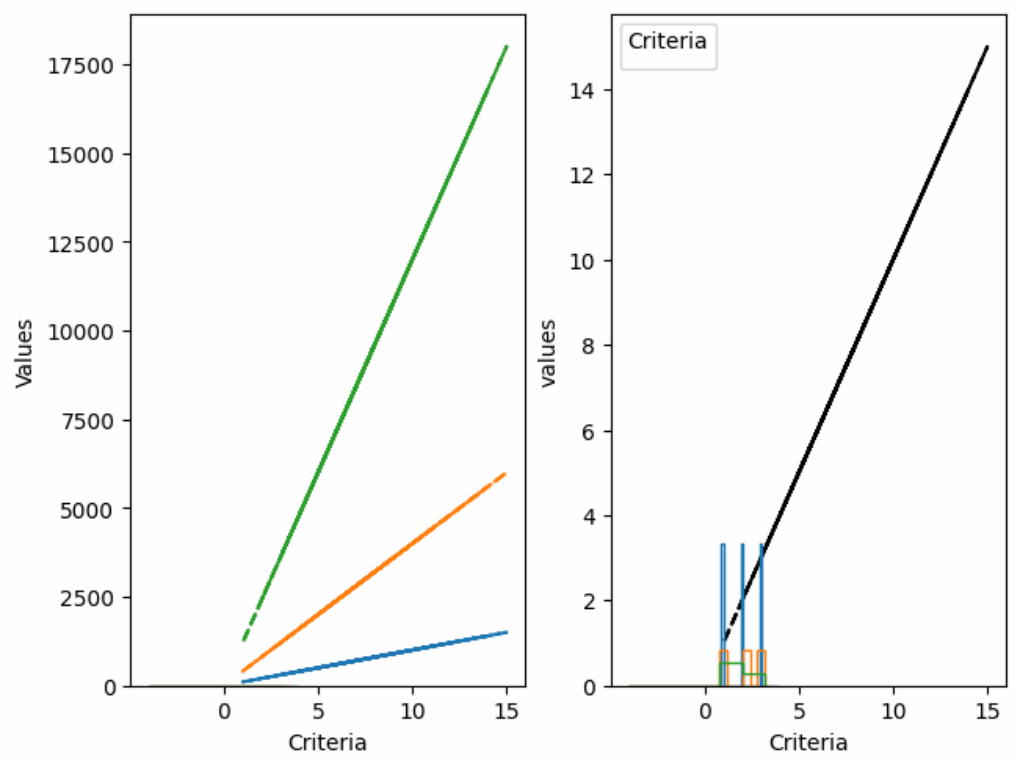

Fig 6. The ranks of alternatives.

4. Analysis

This part shows the sensitivity analysis by updating the weights of criteria by eight cases as shown in Fig 7. Then we apply the MARCOS method to rank the alternatives. Fig 8 shows the utility function. Fig 9 shows the ranks of the alternatives.

Case 1 The focus is evenly distributed, but (C4) has the highest weight (0.3329), highlighting the importance of local involvement in this context. (C1) is low (0.0299), suggesting it's less prioritized here.

Case 2, (C1) is highly emphasized (0.3062), whereas (C2) is minimal (0.0334), suggesting a current-centric approach rather than future-focused transmission.

Case 3 Emphasis shifts to (0.3294) and (0.3368), indicating a dual focus on both people-based sustainability and cultural continuity.

Case 4 Cultural Integrity again scores high (0.3083) along with Intergenerational Transmission (0.3360), while (C4) drops sharply (0.0344)—possibly a more institutional or heritage-preservation-focused case.

Case 5 A more balanced approach across all four criteria, with weights ranging from 0.0580 (C1) to 0.3233 (C4). (C3) and (C2) are strong, suggesting a holistic sustainable model.

Case 6 (C1) is again the lowest (0.2963), while Community Participation (0.3302) takes the lead. This case likely emphasizes collective ownership over individual or symbolic cultural elements.

Case 7 The lowest value is assigned to (C3 – 0.0611), possibly reflecting a community that prioritizes heritage over ecological concerns. High weight to (C4 – 0.3265) again emphasizes collective effort.

Case 8 This case balances the four criteria more equally than most, with all weights between ~0.29–0.33. It reflects a well-rounded evaluation model that does not overly prioritize one aspect.

(C4) consistently receives the highest weights in most cases, underscoring its centrality in sustainable heritage practices.

(C1) shows significant variation, suggesting it is valued differently depending on local or institutional contexts.

(C3) tends to be underweighted in a few cases, indicating a need to raise awareness of ecological aspects in some heritage practices.

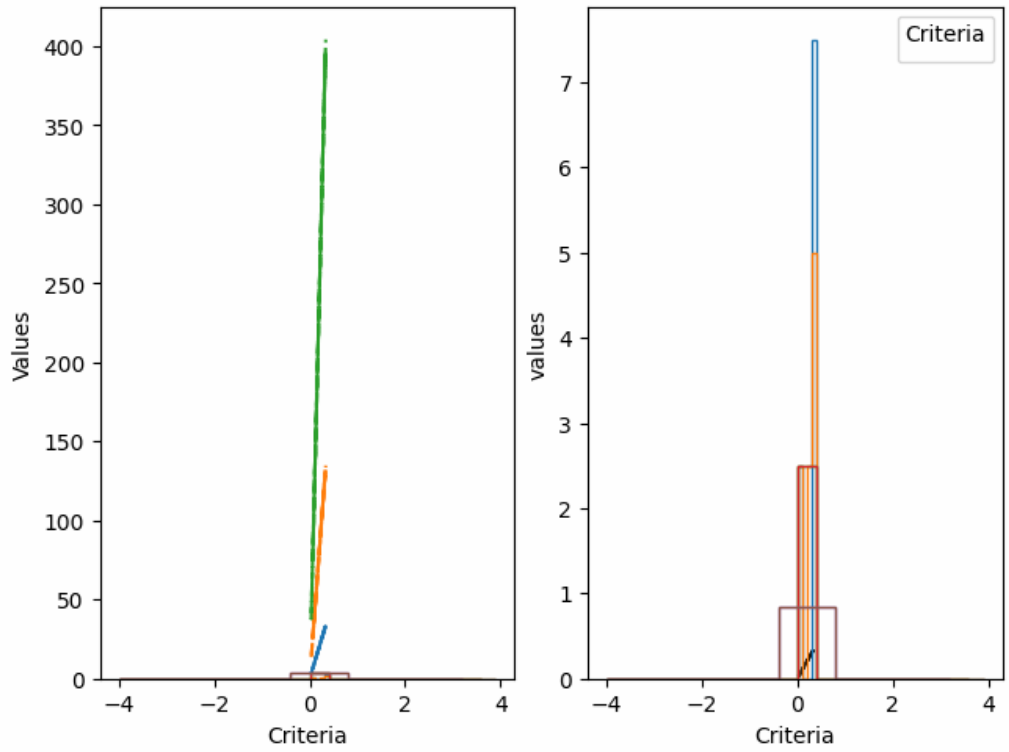

Fig 7. Eight cases in criteria weights.

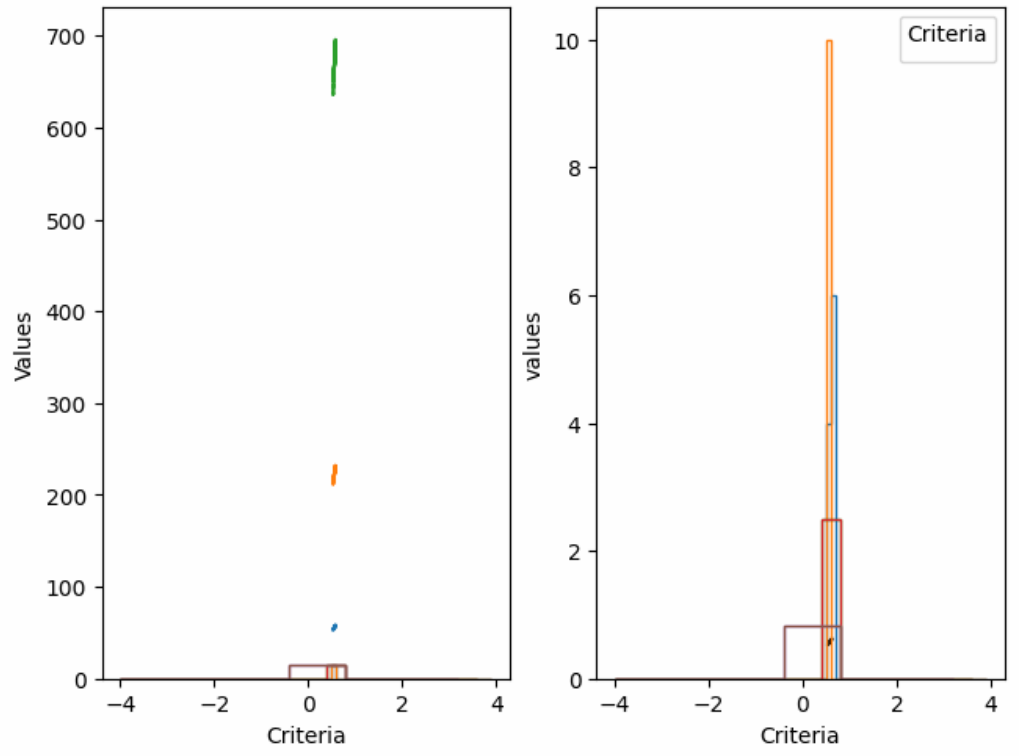

Fig 8. Eight cases in utility function.

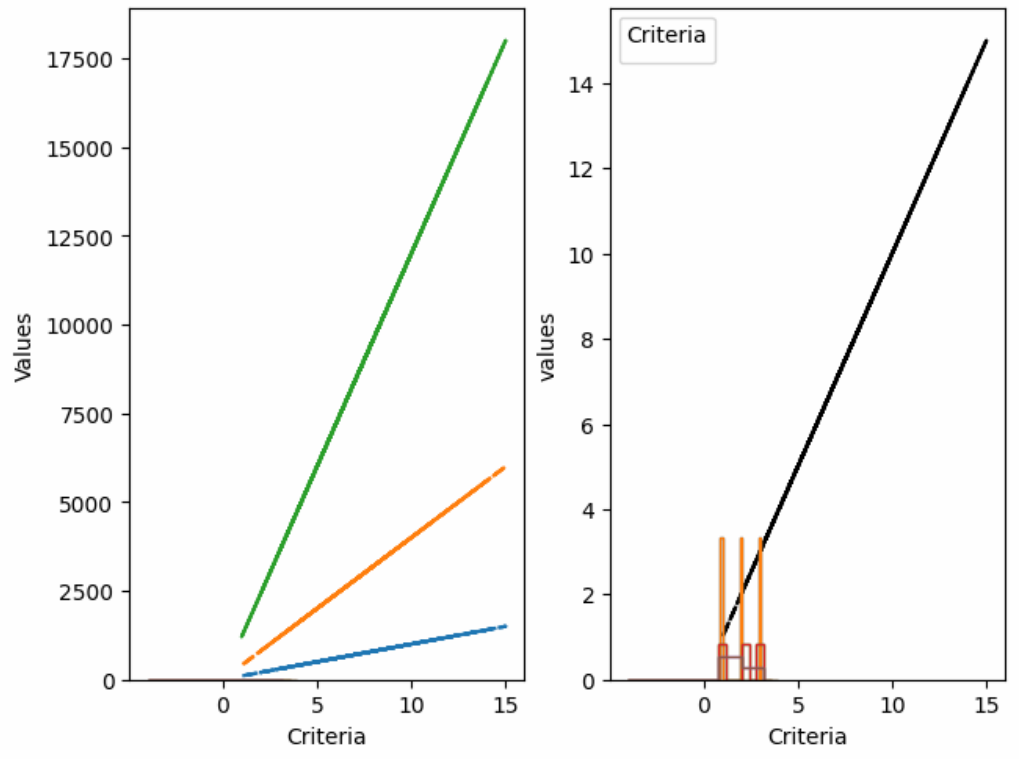

Fig 9. Eight cases in ranks of alternatives.

A1: Moderate to Low Rankings: Ranges from 11 to 14. Generally, underperforms compared to others. May lack comprehensive sustainability elements or strong cultural impact.

A2: Consistently High Performer: Ranks range between 2 and 7. Highly regarded across all scenarios—shows well-rounded sustainability, cultural relevance, and community involvement.

A3: Lower Mid Rankings: Ranks mostly 8 to 11. Seen as sustainable but may lack in certain criteria like environmental alignment or community depth.

A4: Very High Consistency but Low Performance: Always among the bottom three (ranks 13 to 15). Indicates weak alignment with evaluation criteria—possibly outdated methods or lacking participatory dimensions.

A5: Low Performer: Typically ranks 10 to 14. May have cultural value but struggles with practical sustainability or broader engagement.

A6: Top Performer: Frequently Rank 1, with only a couple Rank 2s. Indicates this alternative is the most effective and sustainable by all evaluation criteria.

A7: Middle Tier: Usually ranks 6 to 12. Decent performance but lacks consistency to compete with top-ranking alternatives like A6 or A2.

A8: Upper Mid Performer: Mostly ranks 4 to 9. It shows balanced strengths across different sustainability criteria but isn't top tier.

A9: Lowest Overall: Consistently ranks 13 to 15, usually 15. Perform poorly across all evaluation models. Possibly lacks innovation or relevance.

A10: Mixed Ratings: Ranks range from 3 to 12. Strong in some criteria (e.g., C2 and C6), but possibly inconsistent in delivery or outcomes.

A11: Strong Upper-Mid Performance: Often Rank 2 to 7. Shows clear potential and relevance, particularly in community-driven or intergenerational contexts.

A12: Lower Mid-Tier: Stays around 8 to 11. Might need development or innovation to stand out.

A13: High Performer: Usually between 2 and 5. Frequently ranks in the top 5; likely well-balanced in cultural, environmental, and community aspects.

A14: Mid to Lower Range: Ranks 7 to 11. Offers consistent but not standout value in sustainability efforts.

A15: Highly Competitive: Often Rank 1 or 2, never below 5. Indicates strong integration of sustainability and cultural preservation—among the most favored options.

5. Conclusions

Through sports, intangible cultural legacy can be preserved while providing a special platform for tradition, physical expression, and community building. It has been shown that assessing such practices according to community involvement, intergenerational transmission, environmental compatibility, and cultural integrity produces insightful results. This paradigm makes it possible to establish context-sensitive, culturally respectful policies and tailored actions. Communities can enhance their cultural identity and support global diversity and

heritage preservation by supporting these sports in a sustainable way. This study developed an MCDM approach to evaluate 15 sports under four criteria. Four experts created the decision matrix between the criteria and alternatives. The Triangular UnderConorm is used to deal with different decision matrices. The sensitivity analysis is created with eight cases by changing in the weights of criteria. The results show that the ranks of alternatives are stable in different cases.

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